Bench Assessment

by Michael Budihardjo

WORD COUNT	2461	TIME SUBMITTED	16-OCT-2012 02:26PM
CHARACTER COUNT	12625	PAPER ID	276081812

MY BENCH

Michael Budihardjo Y10Trust

Content

Bench Assessment-
Introduction

I will be designing a bench using quadratic equations. I am aiming to design a bench that is purposed for relaxation, either for home use or outdoor use (balcony).

Initial Bench Research:

A common bench includes the following two things: the seat and the back. These are the main components to a successful chair. The chair will be one for relaxation; therefore I will also add armrests to the chair.

Human Body Measurement

Different people have different needs. When it comes to buying a chair, it is important that the chair's height and back are long or short enough for maximum comfort. The average height of person born from Hong Kong would be 172cm; therefore I will use this as a standard to design my chair.

Firstly, the seat of the bench must be high enough for the average person to sit on. The occupant's feet would just touch the ground and knees would be at an angle of 90-100.

The back of the bench supports the lower back; therefore it shouldn't slant back too much. Slanting it to about 20-40 inches would probably be enough, since it is a relaxation chair.

The armrest shouldn't have to force the shoulders of the occupant to elevate; therefore the armrest should be built 17-22cm above the seat. The armrest would be around 20cm long and 5-10cm wide to fit the forearms. And the two forearms spaced around 50cm apart.

"Human Height." *Wikipedia*. Wikimedia Foundation, 13 Sept. 2012. Web. 13 Sept. 2012. <http://en.wikipedia.org/wiki/Human_height>.
"Must-have Measurements for Comfortable Seating." *WoodMagazine.com*. N.p., n.d. Web. 14 Sept. 2012. <http://www.woodmagazine.com/woodworking-tips/techniques/must-have-measurements-for-comfortable-seating/>.

For designing the chair, the measurements of the back and legs are required. The back measurement is for the back of the chair and the legs measurements are for calculating how high should the chair be at. The average person is 172cm; therefore I will do some estimating. Cutting a person of 172cm in half, the upper back part should be about 86cm and the legs are also 86cm long.

Examples of chairs for reference – (from classroom)

Chair 1= height 40 cm width 44 cm	height total 75 cm
Chair 2= 51cm height width 41cm	height total 82cm
Chair 3= 35cm height width 43cm	height total 90 cm

Function Research

The standard form for the quadratic equations is $ax^2 + bx + c = 0$, where there is an x^2, x and one by itself which has no x^2 or x. 'a' is also never a zero, because if so then the x would be zero and without a square (^{2}) then it would be a linear equation.

So in a quadratic equation, the simplest equation is when a=1 and b & c= 0, therefore becoming $y=x^2/y=1x^2$

In $y=ax^2$, the curve will be wider if 'a' (multiplication number) is a small number, and vice versa.

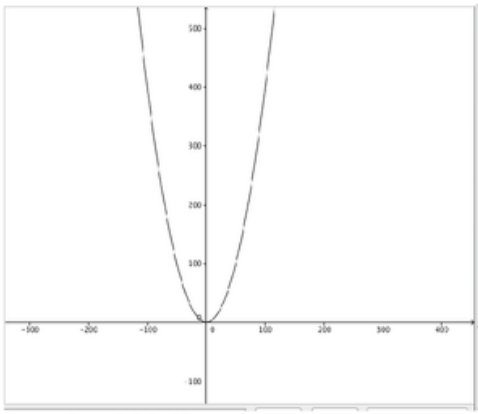


Figure 1: y=0.04x^2

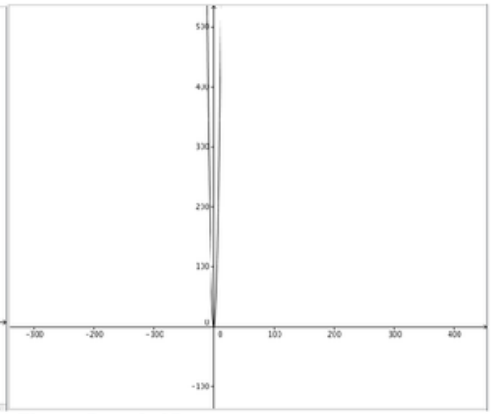


Figure 2: y=4x^2

If 'y' is a negative, then the curve will be upside down.

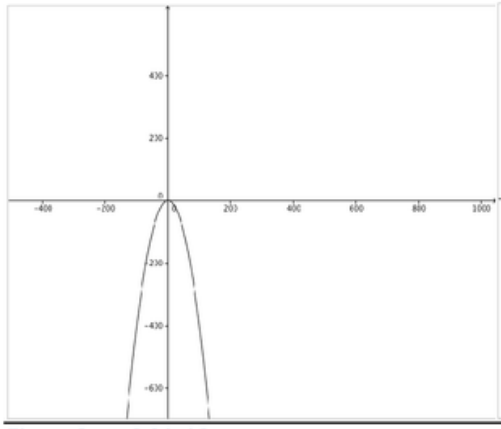


Figure 3: -y=0.04x^2

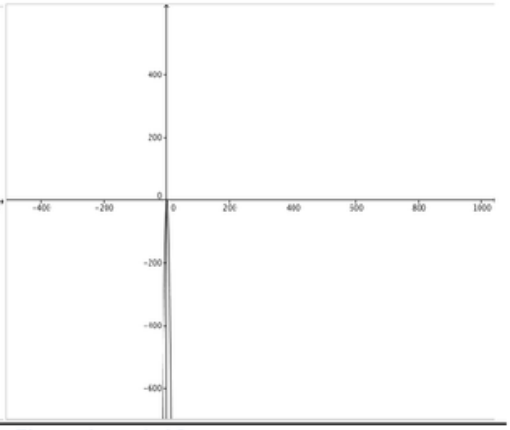


Figure 4: -y=4x^2

This is a translation called reflection, which the curve will produce a mirror image of the original one.

In y= (a+b) ^{2}, the curve will be on the negative side of the y-axis, if the product of 'a' and 'b' is a positive, and vice versa.

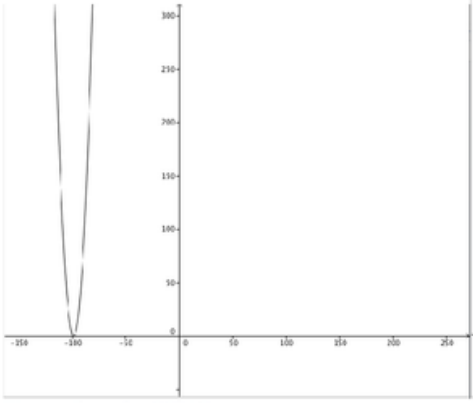


Figure 5: y=(x+99)^2

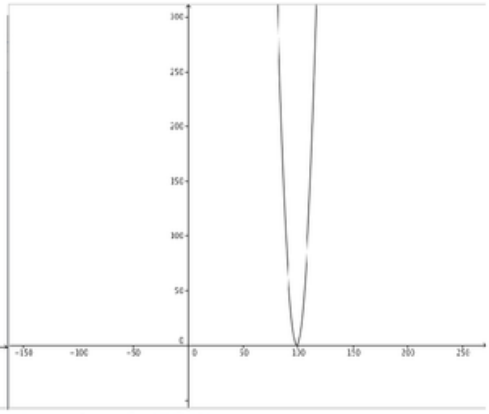


Figure 6: y=(x-99)^2

This is a function called the horizontal translation, used to modify the position curves are.

If 'a' were a negative, then the rules would be the opposite.

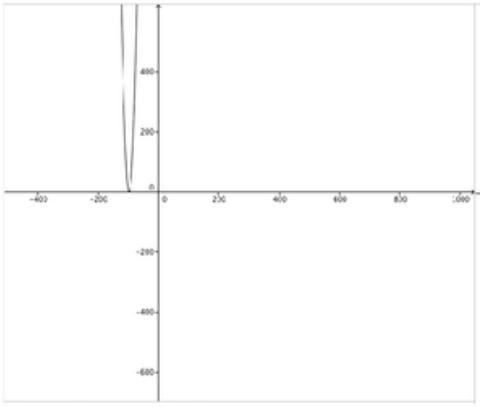


Figure 7: y=(-x-99)^2

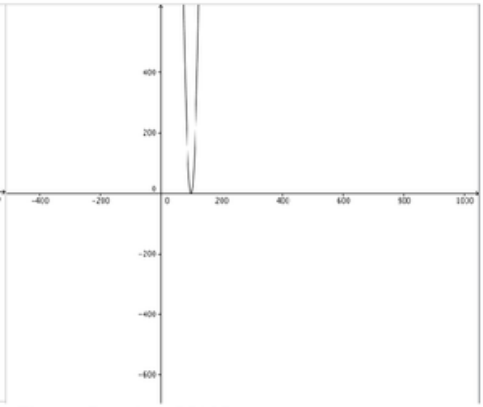


Figure 8: y=(-x+99)^2

This is a translation called reflections, where the curve will become a mirror image of the original curve.

In $y= a^2+b$, the curve will not advance through the x axis if the equation is an adding equation, and if it is a subtracting equation, the curve will go down below the x axis, into the negative area.

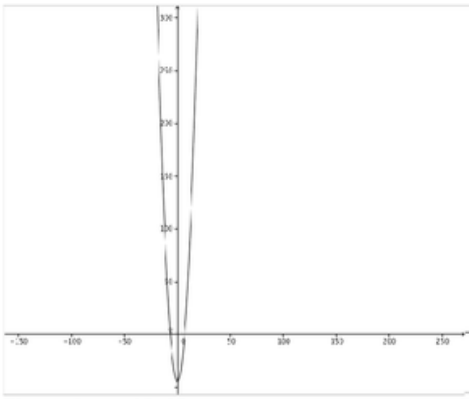


Figure 9: y=x^2-45

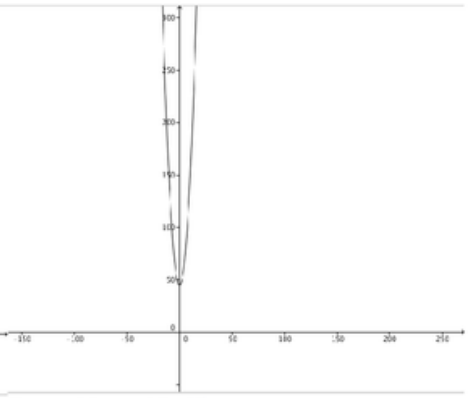


Figure 10: y=x^2+45

This is a translation called the vertical translation, used to modify the heights of the curves.

The number of the multiplication number is a small number; therefore the curve line will be wide. Also the equation is an addition equation inside the brackets, so the curve will be on the negative side of the y-axis.

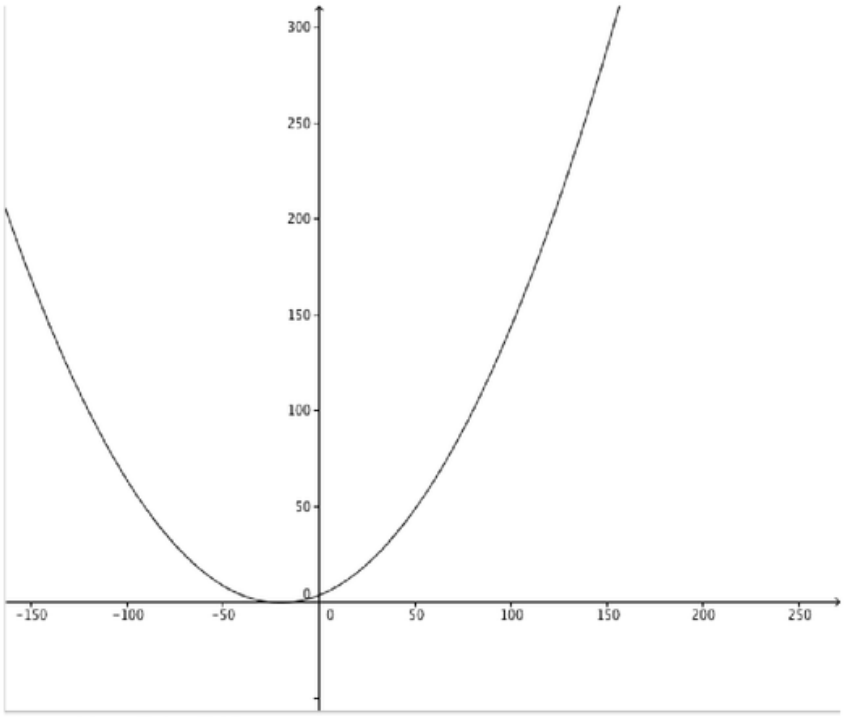


Figure 11: y=(0.1x+2)^2

Cubic Function

Say the equation $y=(x+1)^3$, , the curve will be on the negative side of the y-axis, if the number adding inside the bracket is a positive, and vice versa.

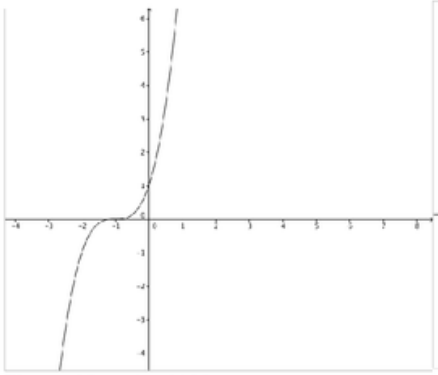


Figure 12: y=(x+1)^3

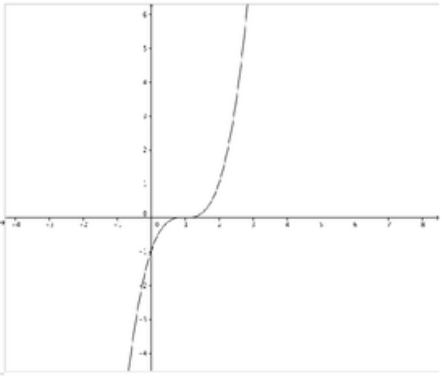


Figure 13: y=(x-1)^3

Initial Bench Design

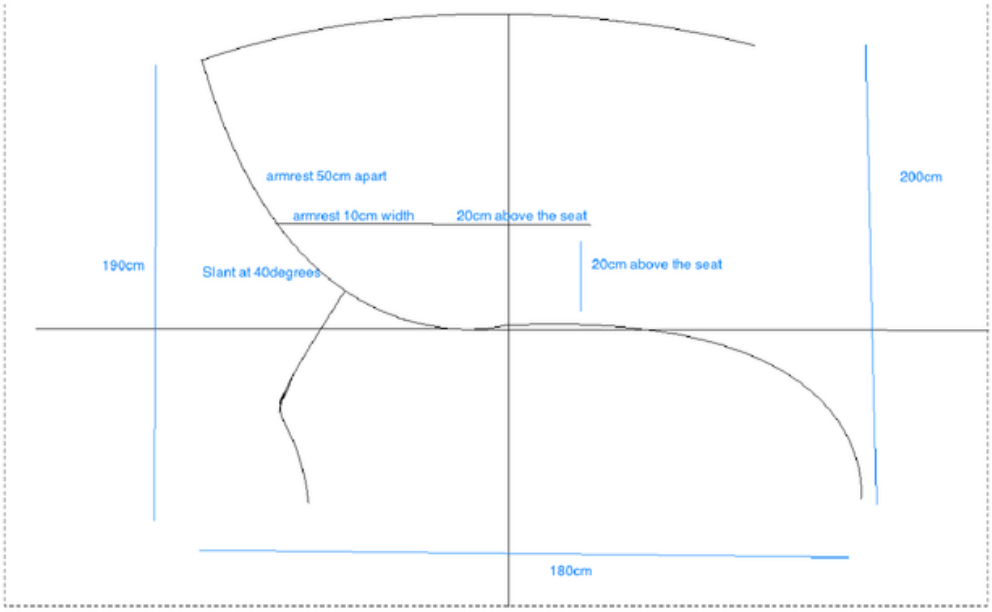


Figure 14: Initial Design

This is a sketch of the bench. The measurements apply to the research. An average human body is 172 cm, so the height and length of the bench would be 190cm and 180cm to leave some space for comfort.

Criterion A - Bench Design:
Process of finding the equation:

Entire Body of Bench- $y=-0.000001x^3$

The equation is a cubic function. The equation is for the seat of the bench. In the final sketch, I have cut the equation into proper lengths for the bench, where -1000<x<800 and 1100<y<-500, which means it is 180cm in length and 1600cm in height.

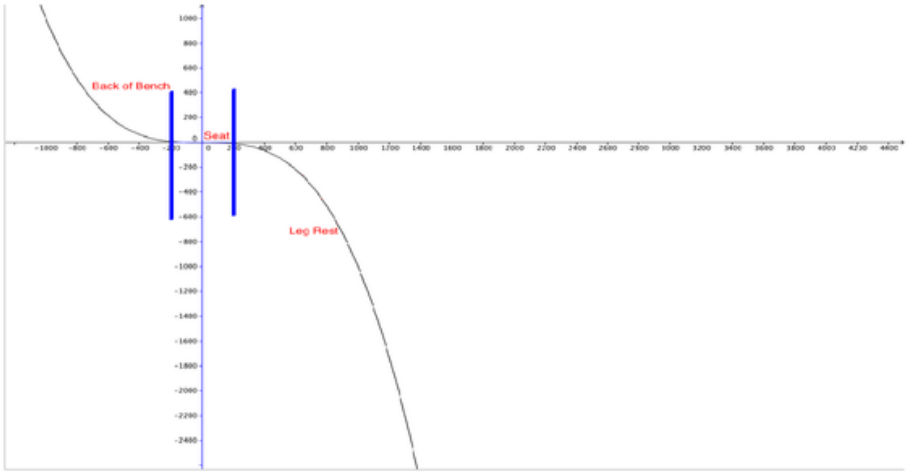


Figure 15: Body of bench, equation: y=-0.000001x^3

Leg Rest-

The leg rest is from the previous equation with the cubic function. It starts from x=200 and ends at x=800 and y=-500, therefore the length of it is 60cm.

Seat-

The seat of the bench is from the previous equation with the cubic function. The seat is where -200<x<200, which is 40cm in total.

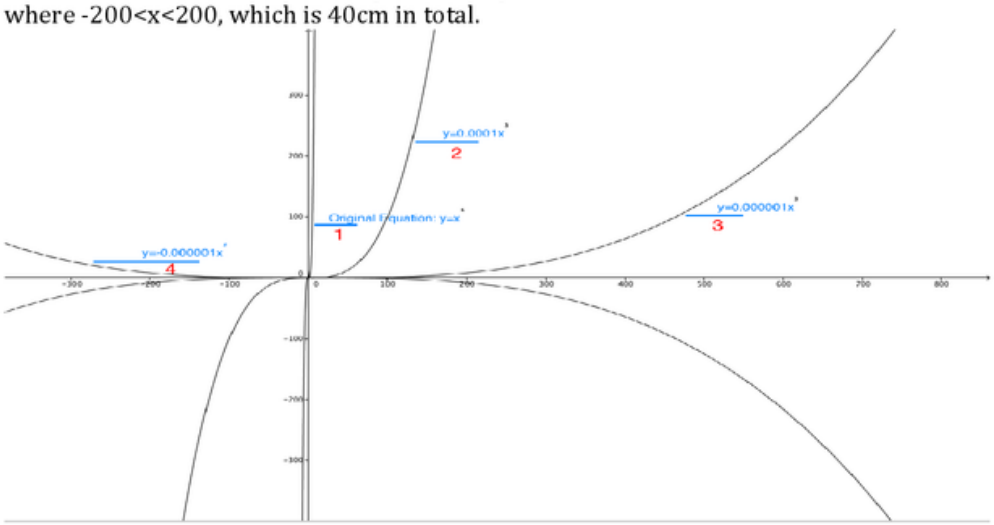


Figure 16: Process of finding the equation y=-0.000001x^3 (Each process labeled 1-4)

The above shows the progress of finding the equation. The original equation is y=ax^3, where 'a' is a number that determines the width of the curve. The original curve is the one with number 1 under it. Then I multiplied it with a number smaller than 1, in this case 0.0001, since a small number would make the curve wider, and by doing this I would be able to achieve a longer seat for the bench. Then I minimized the number even more, into 0.000001, which is the third curve. I saw that the curve is in the length that I wanted, therefore to finish it, I used reflection by changing the number into a negative, $-0.000001x^3$, to have the bench positioned on the left.

Bench Legs- $y=-(0.1x+40)^2+59$

The equation is a quadratic function using enlargement, reflection, vertical and horizontal translation. The legs are attached to the body of the bench ($y=-0.00001x^3$) where y=25 units and x=-400 units. The quadratic equation is cut where -800<y <25, meaning it is 82.5cm in length. It also means the bench is 82.5cm above the ground.

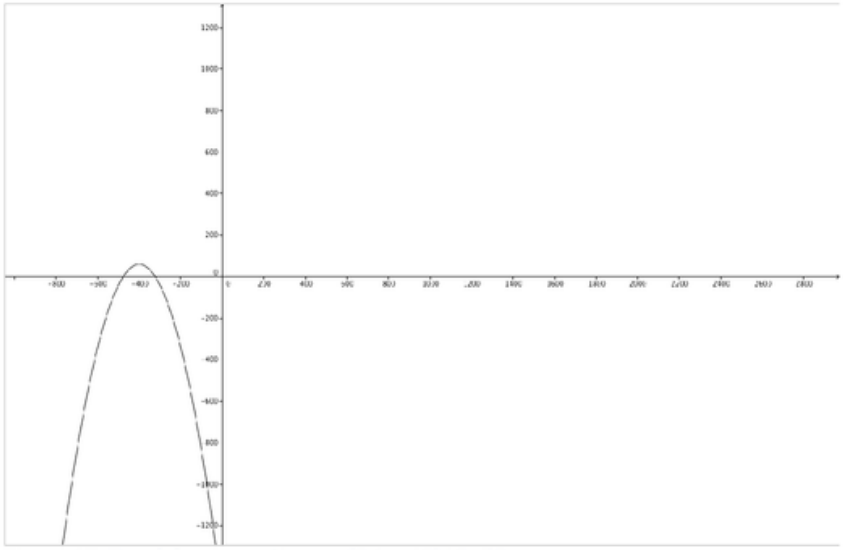


Figure 17: Bench legs, equation: y=(0.1x+40)^2+59

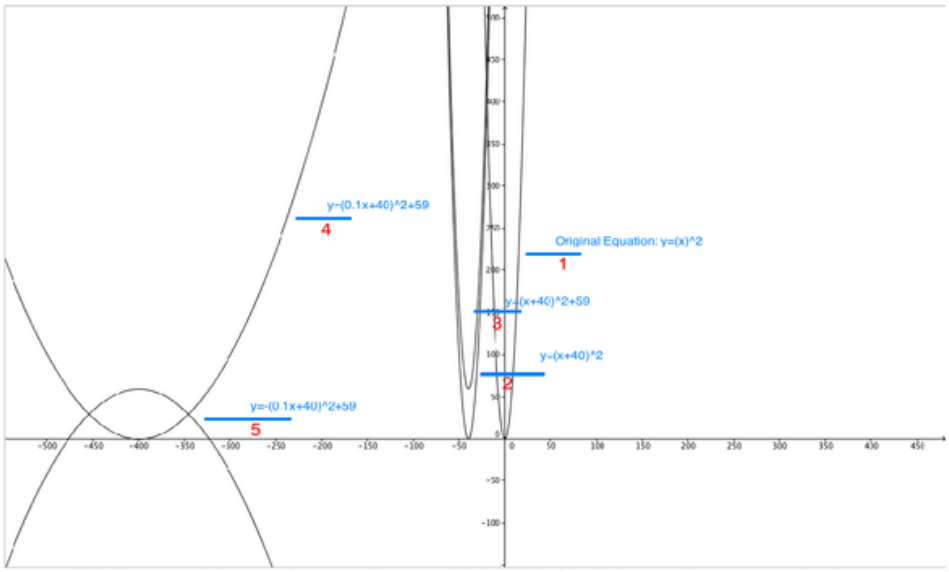


Figure 18: Process of finding the equation y=-(0.1x+40)^2+59 (Each step labeled 1-5)

The above shows the process of finding the equation for the bench legs. The original equation is y=(x)^2/y=x^2. I would add 40 to 'x' in the bracket, which would shift the equation 40 units to the left .The reason for 40 is because the final number I want is 400. Then adding 59 outside the bracket to vertically translate the curve up by 59 units. Then to enlarge it I would multiply 'x' by 0.1 inside the bracket. Lastly since it's the bench's legs, it should be facing downwards, therefore I would reflect it across the x-axis by making (0.1x+40)^2 into a negative number.

Arm Rest - $y=-0.0001x^2+400$

The equation is a quadratic equation using enlargement and vertical translation. There are two armrests on the bench, therefore there is supposed to be two of the same equations. The equation is cut where -500<x<500 and y<400. The armrests are 100cm in length and are 120cm above the ground. There are two of the equations since it is an armrest, which has both sides.

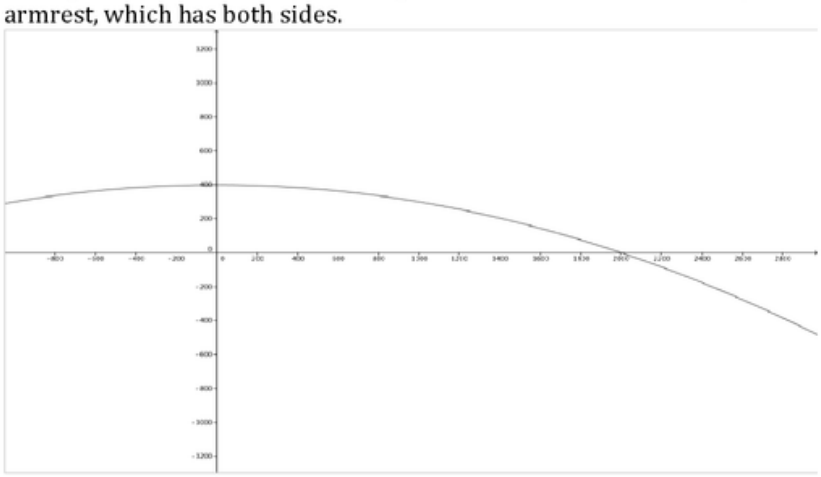


Figure 19: Arm rest, equation: y=-0.0001x^2+400

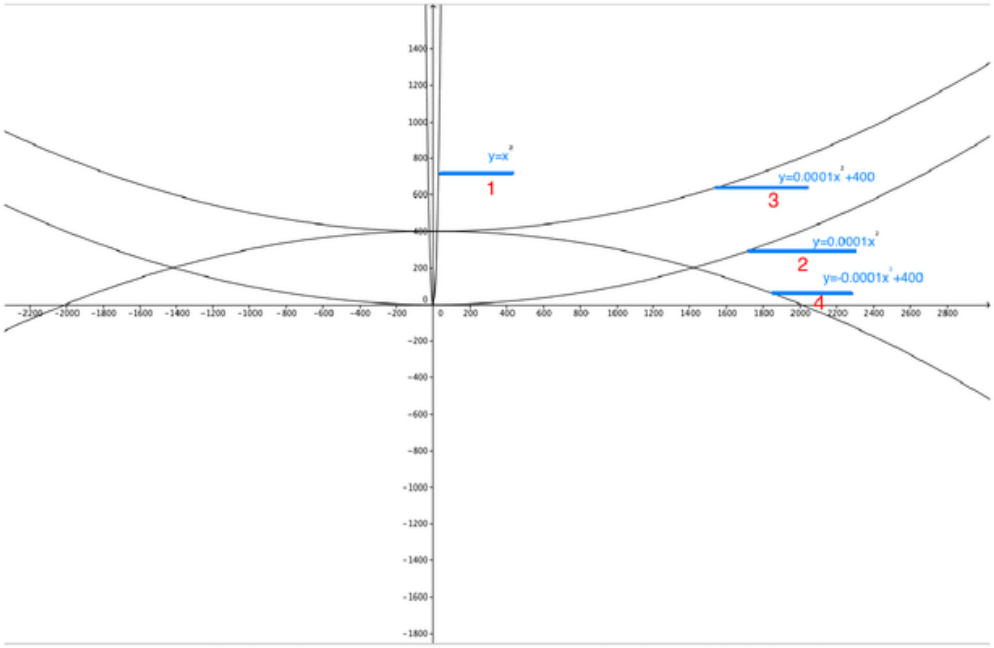


Figure 20: Process of finding the equation y=-0.0001^2+400 (Each step labeled 1-4)

The above shows the process of finding the equation for the armrest. The original equation to start from is $y=x^2$. I would widen the curve for a longer length by multiplying it with a small number, shown in step 2, multiplying 'x' with 0.0001. Then by using vertical translation, I would move the curve up by 400 units so it would have a good height to rest the arms of the user. Finally to make the curve into the proper direction, the number 0.0001 is converted into a negative number.

Head Cover - $y=-0.0001x^2+1200$

The equation is a quadratic equation using enlargement and vertical translation. The head cover is -1000<x<600 and y<1200, therefore the length of it is 160cm in length and 1700cm in height.

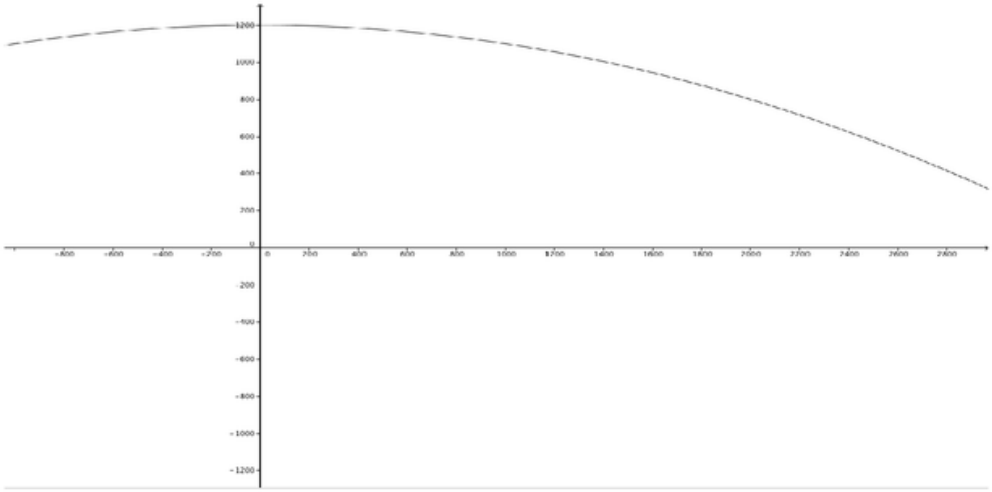


Figure 21: Head cover, equation: y=-0.0001^2+1200

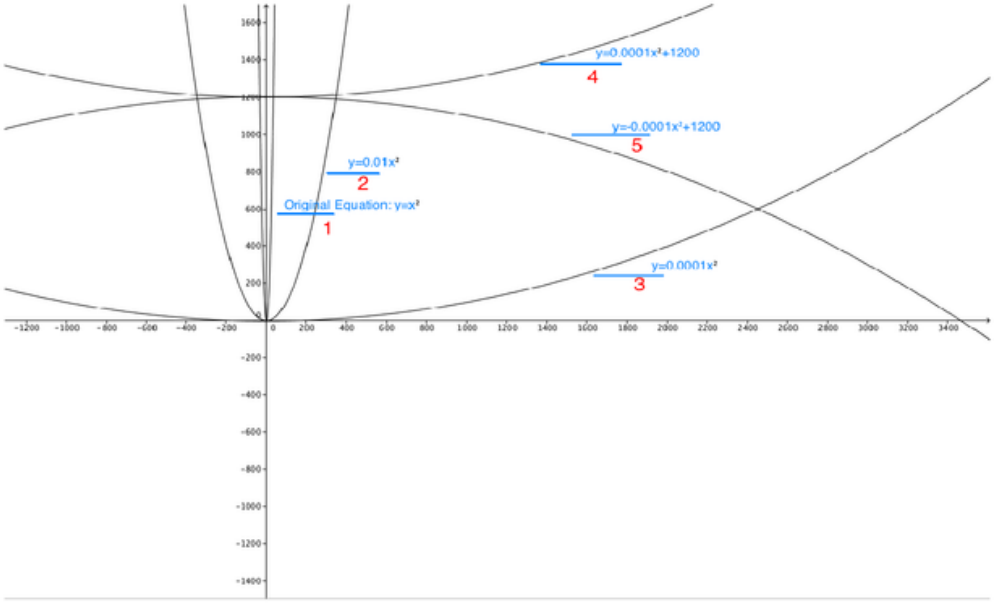


Figure 22: Process of finding the equation y=-0.0001x^2+1200 (Each step labeled 1-5)

The above shows how I found out the equation for the head cover of the bench. The original equation is $y=x^2$, shown in the image. The head cover needs to be wide enough (or long enough) to cover most of bench, therefore I multiplied 'x' with a small number, 0.01 and then 0.0001 respectively to achieve the equation $y=0.0001x^2$. The head cover needs to be on top of the bench, therefore I moved it by using vertical translation, adding 1200 to the equation, it would shift the curve upward by 1200 units, or 120cm in the finalized sketch. Finally reflecting the curve by changing the 0.0001 into a negative, the curve would flip into the right direction to act as a cover.

And with all the equations, I would finally have assembled the bench, with specific measurements shown in the image.

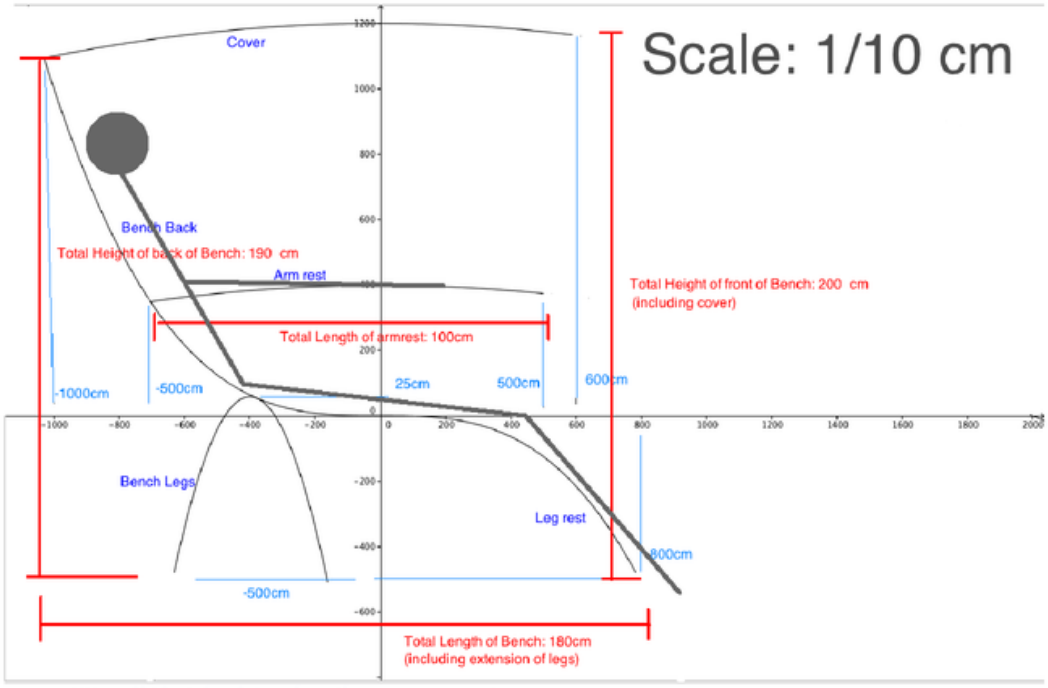


Figure 23: Full Sketch of Bench with measurements

Final Sketch of bench:

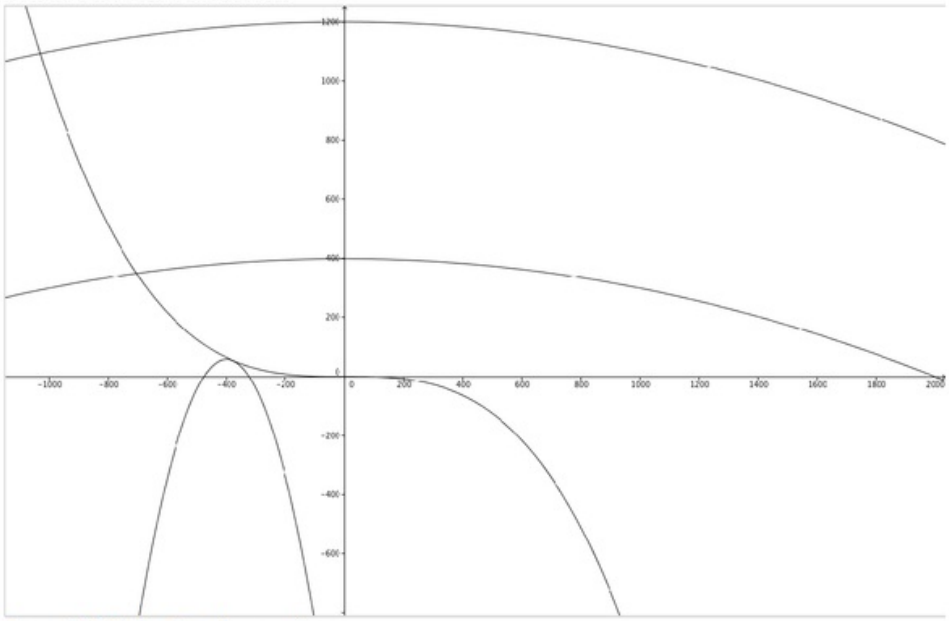


Figure 24: Entire Bench, equations:

y=-0.000001x^3

y=-(0.1x+40)^2+59

y=-0.0001x^2+400 (2 of the same equation since it's the arm rest)

y=-0.0001x^2+1200

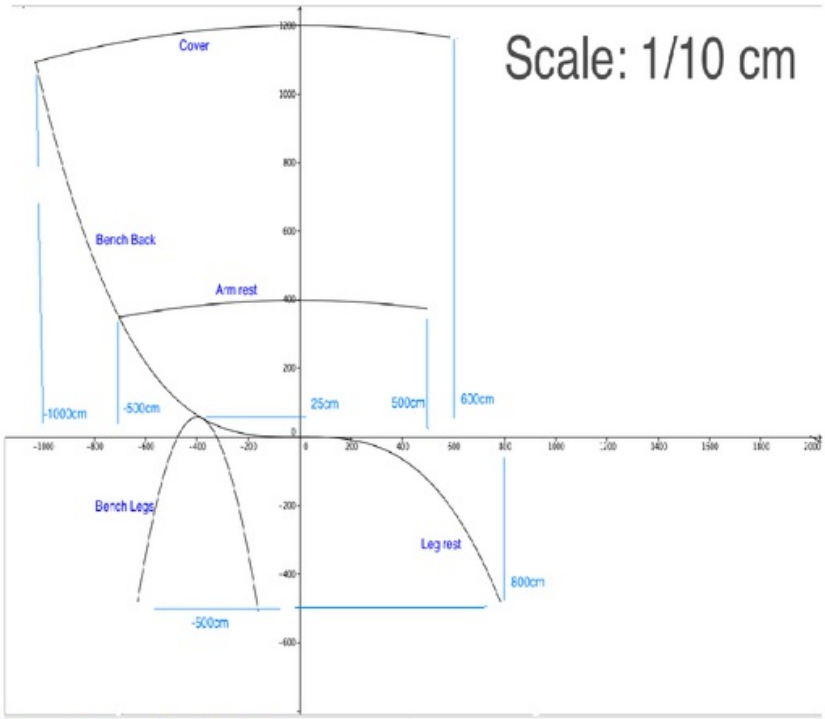
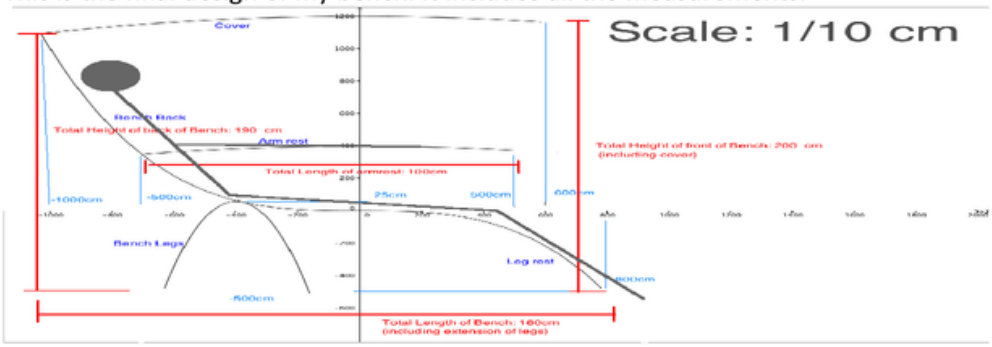


Figure 25: Final Sketch with measurments

Criterion D:

This is the final design of my bench. It includes all the measurements.



Size and comfort levels –

During the research, I found out that the height of an average person would be 172cm, round it down and divide it by two, it would be 85cm in length for the upper body and lower body. The most important thing of designing the bench is to make sure that the bench suits the user most, offering them a bench that is most comfortable.

The bench is 180 in total; the back of the bench is about 60cm. When the average person is sitting on the bench, their buttocks should be positioned at about the -200 units mark in the image, which leaves 80cm for the back and 100cm for the legs. The space should be more than enough for the average person, so it should be really comfortable. The seat overall leaves enough space for flexibility, not limiting on how the user wants to sit, for example they have the option of sliding down a bit on the bench since there is some leg space left.

The height of the bench is 80cm, and while the legs of the average person is 85cm, the average user should have no problem stepping over onto the bench. The armrest is 100cm, which should be more than enough for the average person to rest their arms on.

Acts on sunshine and rain-

The head cover is positioned even higher; therefore the user shouldn't bump their head on it. It is intended to defend the user from extreme sunlight and rain. The cover extends longer than the seat; therefore the cover can fully protect the user from sunshine and rain.

Flexibility on storage-

The size of the bench is reasonable; it fits the average person with a bit of room left. The flexibility of storing the bench should be quite good because the bench is not really huge.

Overall analysis of the bench-

The bench is designed for indoor and outdoor use, aimed for relaxation. The slanted curve on the back makes the bench more comfortable and the overall size of the bench is fit for the average person to use. The combined functions used to create the bench, although it is unusual in someway, it is still able to preserve a basic look of a chair.

Degree of Accuracy-

In the initial design, I designed the bench mostly by according to my research to achieve a better bench. In the design, the different parts of the bench, for example the seat, armrest and head cover are measured in terms of height and length since they are the basic things needed to create a bench. By using parabolas, I have control over the heights and lengths of the curves, even the slightest unit in terms of height and length.

Percentage Errors-

But referring to the initial design, there are some aspects that cannot be met with only using parabolas.

The degree of the bench cannot be calculated since I only have control over the height and length.

I also cannot include the width of the bench since it is in 2-D format, therefore unrealistic.

For the equation of $y=x^3$, although the curve reaches the certain correct length, there are curves within the curve which when measured in a straight line, it would be longer than what it is supposed to be.

Improvements-

When designing a bench, I could have considered the fact that a bench in real life is actually a 3-D object. And if I were to design a bench, I would need to use more complex equations and even more equations to create the length, height and width of an object. In this case, GeoGebra is not good software to use in order to design a realistic bench.

I could have also considered that the material used to create a bench has its own thickness. Different materials have different thickness, which it would affect the measurements, while in the design, I just used a thin line.

Bibliography:

"Graphing Quadratic Equations." *Graphing Quadratic Equations*. N.p., n.d. Web. 14 Sept. 2012. <http://www.mathsisfun.com/algebra/quadratic-equation-graphing.html>.
"Human Height." *Wikipedia*. Wikimedia Foundation, 13 Sept. 2012. Web. 13 Sept. 2012. <http://en.wikipedia.org/wiki/Human_height>.
"Must-have Measurements for Comfortable Seating." *WoodMagazine.com*. N.p., n.d. Web. 14 Sept. 2012. <http://www.woodmagazine.com/woodworking-tips/techniques/must-have-measurements-for-comfortable-seating/>.
"SOLUTION: The Parabola with Equation {{{y-3=(x-4)^2}}} Has It's Vertex at (4,3) and Passes through (5,4). Find an Equation of a Different Parabola with Its Vertex at (4,3)that Passes through." *SOLUTION: The Parabola with Equation {{{y-3=(x-4)^2}}} Has It's Vertex at (4,3) and Passes through (5,4). Find an Equation of a Different Parabola with Its Vertex at (4,3)that Passes through*. N.p., n.d. Web. 14 Sept. 2012. <http://www.algebra.com/algebra/homework/Quadratic-relations-and-conic-sections/Quadratic-relations-and-conic-sections.faq.question.138701.html>.
GeoGrbra. Computer software. Vers. 3.2.47.0. N.p., n.d. Web.
Soggy Waffles. *Paintbrush*. Computer software. Vers. 2.1.1. N.p., n.d. Web.

GRADEMARK REPORT

FINAL GRADE
/ 0

GENERAL COMMENTS

PAGE 1

PAGE 2

PAGE 3

PAGE 4

PAGE 5

PAGE 6

PAGE 7

PAGE 8

PAGE 9

PAGE 10

PAGE 11

PAGE 12

PAGE 13

PAGE 14

PAGE 15

PAGE 16

PAGE 17

PAGE 18